ABSTRACT

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An Improved Theoretical Ni-Cd Battery Performance Model

By Paul J. Timmerman

Jet Propulsion Laboratory / California Institute of Technology

Previous reports have shown how a battery model was developed using porous electrode theory. The model was first reported in 1989. Since then the model has upgraded and expanded. These refinements include oxygen reaction and positive electrode intercalation (1990), and proton diffusion (1992) . The model has been used to predict performance of Ni-Cd cells with good results. Beyond the electrochemical aspects, the higher level battery modelling aspect have been integrated. These include model includes power subsystem, thermal (1989), cell design, and degradation aspects (1993) .

Previous theoretical models have suffered from an inability to accurately predict potentials as a function of charge and discharge rate, The accuracy of this model was improved by extending the nickel electrode equations. Specifically, the expression for solid phase conductivity of the nickel electrode was expanded. In addition to an existing "bulk" semi-conduction effect, a term was added to simulate a Schottky junction within the active material layer. 'I'his term provides an over--potential which saturates with increasing rate. 'l'he over-potential is asymmetric with respect to charge and discharge, (oxidation and reduction). The asymmetry observed is consistent with the active material being an N--type semiconductor,as reported. The resulting predictions are improved over all previous efforts.

The results are compared to a variety of actual data from electrodes, cells and batteries. The model shows significant improvement against each of these types of data. The results are discussed with respect to the model of the active material layer, and the intrinsic assumptions of the model . The abilities of this model to perform spacecraft simulations will also be discussed. 'l'he implications for modeling other nickel cathode battery systems are discussed. Ni.-H2, Ni-MH, and Ni-Zn models may all benefit from this improvement .